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Havinis et al.

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(54) **SYSTEM AND METHOD FOR MONITORING POSITIONING REQUESTS FOR MOBILE SUBSCRIBERS**

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(52) **U.S. Cl.** **455/456**; 455/404; 455/406
(58) **Field of Search** 455/456, 404, 455/406; 342/357.13, 457

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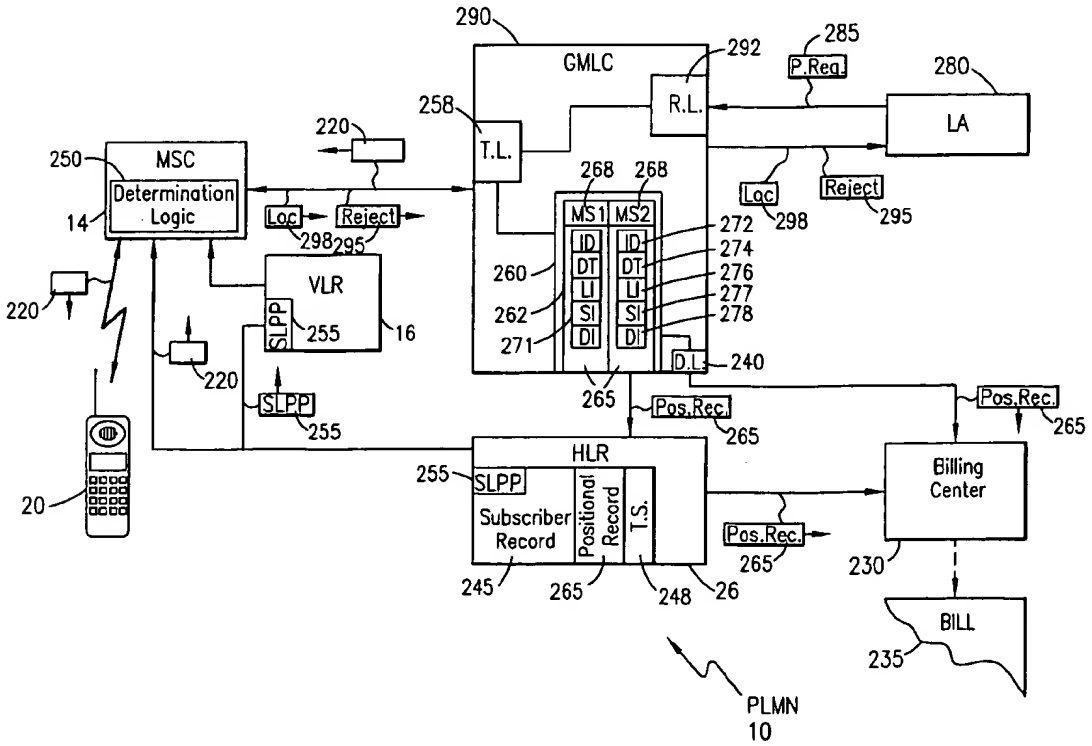
(57) **ABSTRACT**

A telecommunications system and method is disclosed for monitoring all successful and unsuccessful attempts by third parties to locate a mobile subscriber and providing identity information associated with those third parties to the mobile subscriber. Whenever a positioning request is received by a Gateway Mobile Location Center (GMLC), the GMLC, before returning a response to the requester, e.g., either location information or a rejection message, maintains a positioning record of all information related to the positioning request for the mobile subscriber, including the identity of the requester. The GMLC can download this positioning record to a node associated with the mobile subscriber, such as a Mobile Station (MS) or billing center.

24 Claims, 7 Drawing Sheets



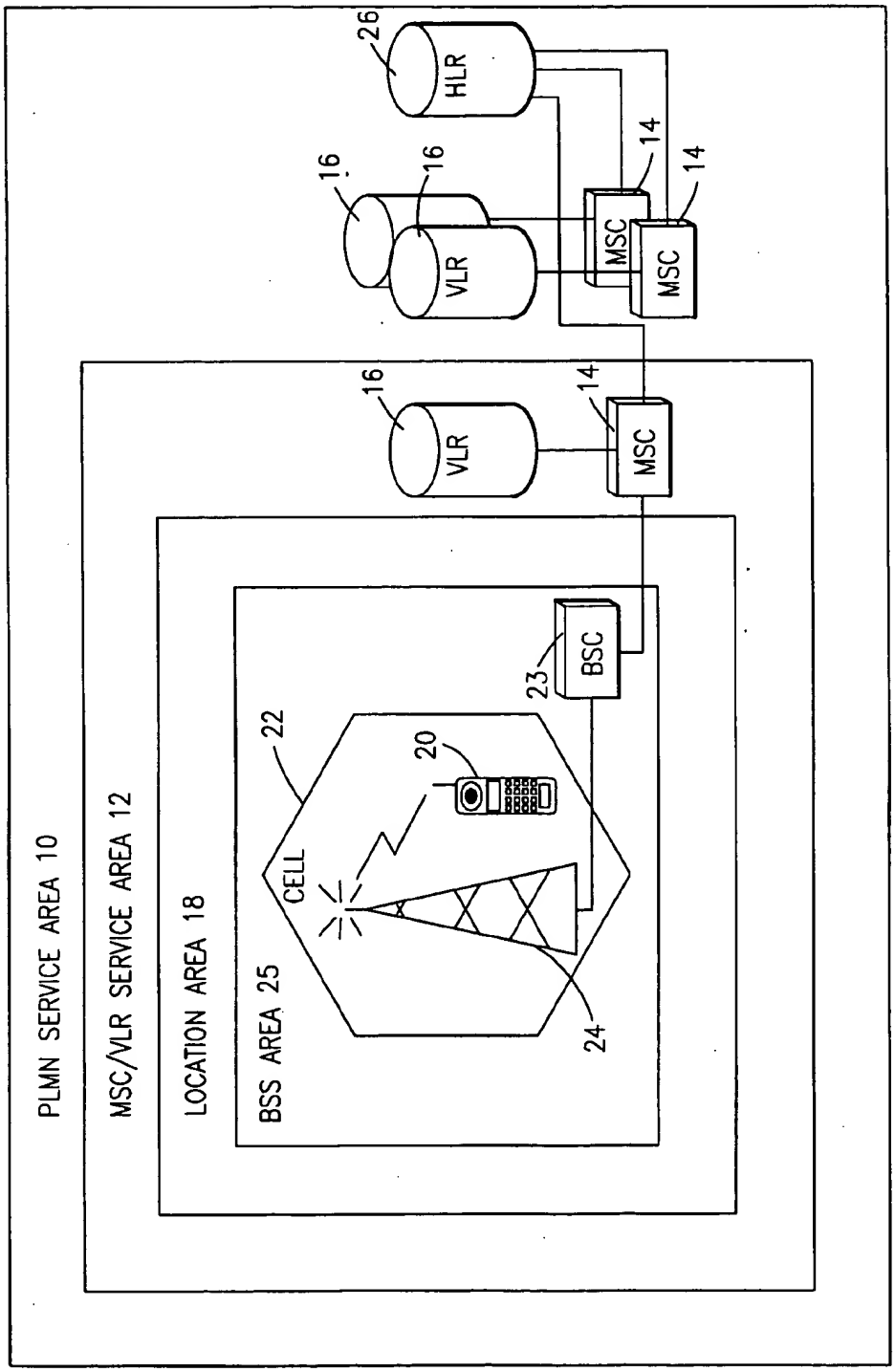


FIG. 1
(PRIOR ART)

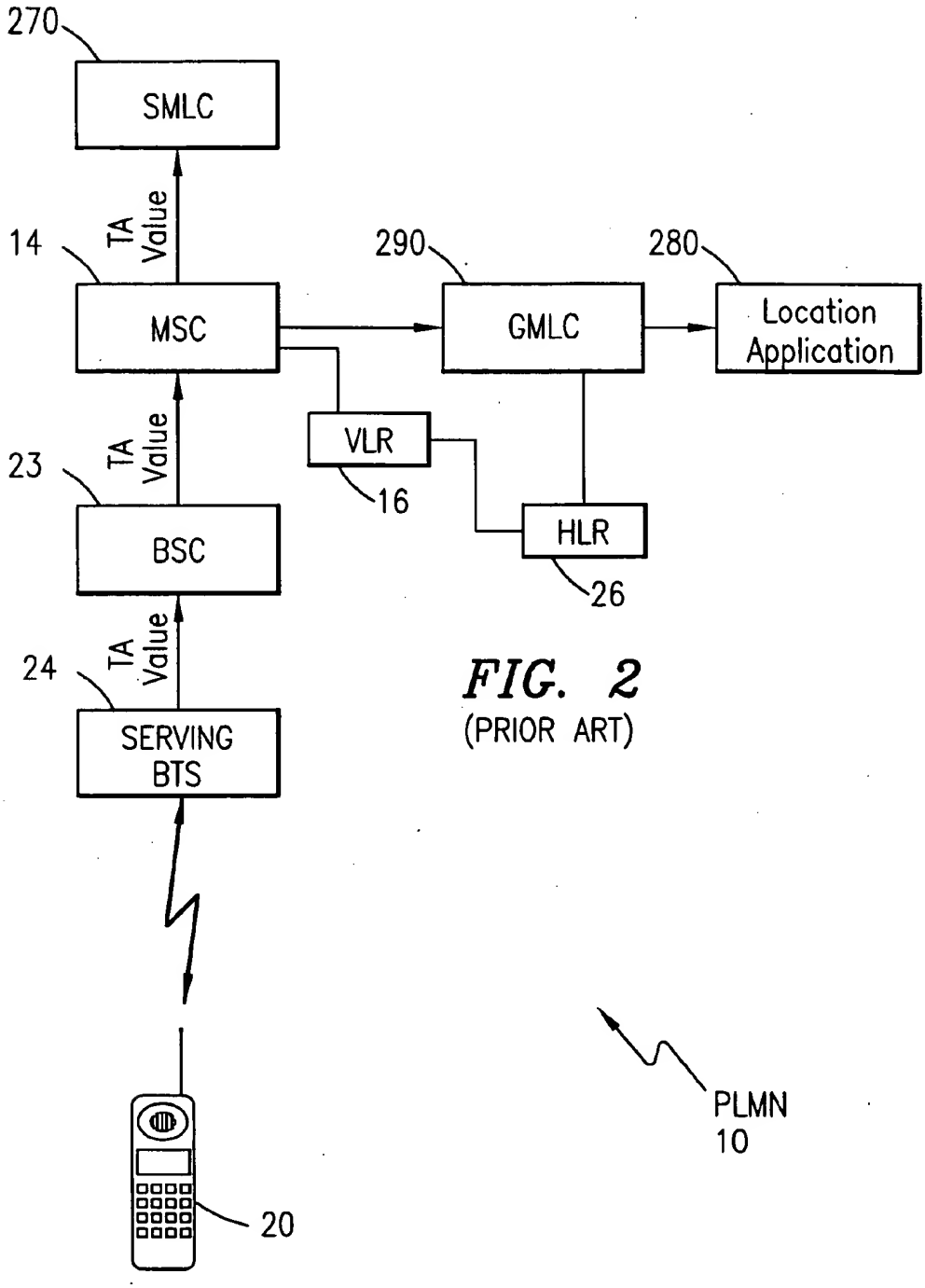


FIG. 2
(PRIOR ART)

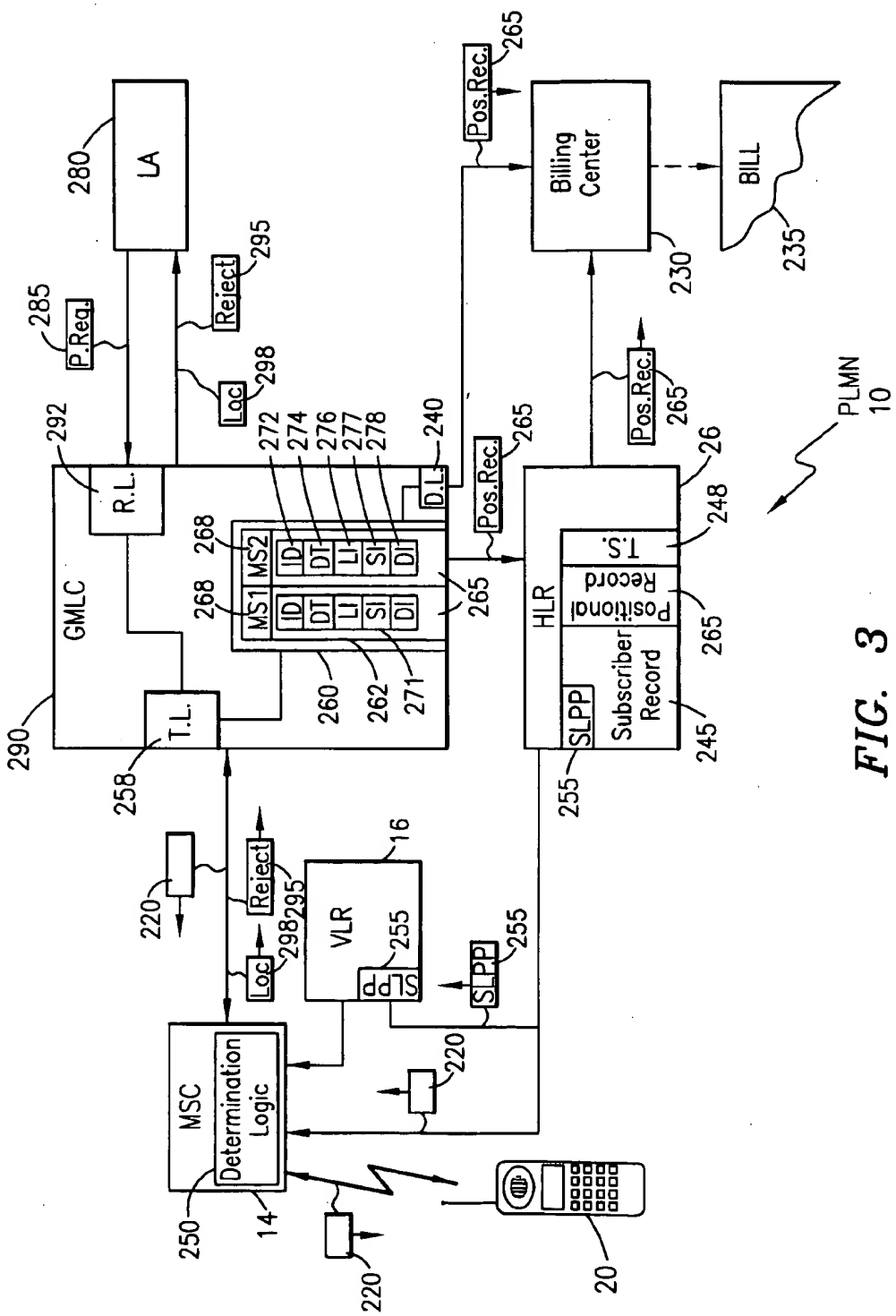

LA
280
P.Req.
285
Reject
295
Loc
298
GMLC
292
R.L.
T.L.
290
258
MS2
MS1
ID
DT
LI
SI
DI
268
272
274
276
277
278
240
D.L.
260
262
271
265
Pos.Rec.
Billing Center
230
BILL
235
HLR
26
T.S.
248
Position Record
Subscriber Record
SLPP
245
255
VLR
16
220
MSC
Determination Logic
250
14
20
PLMN
10

FIG. 3

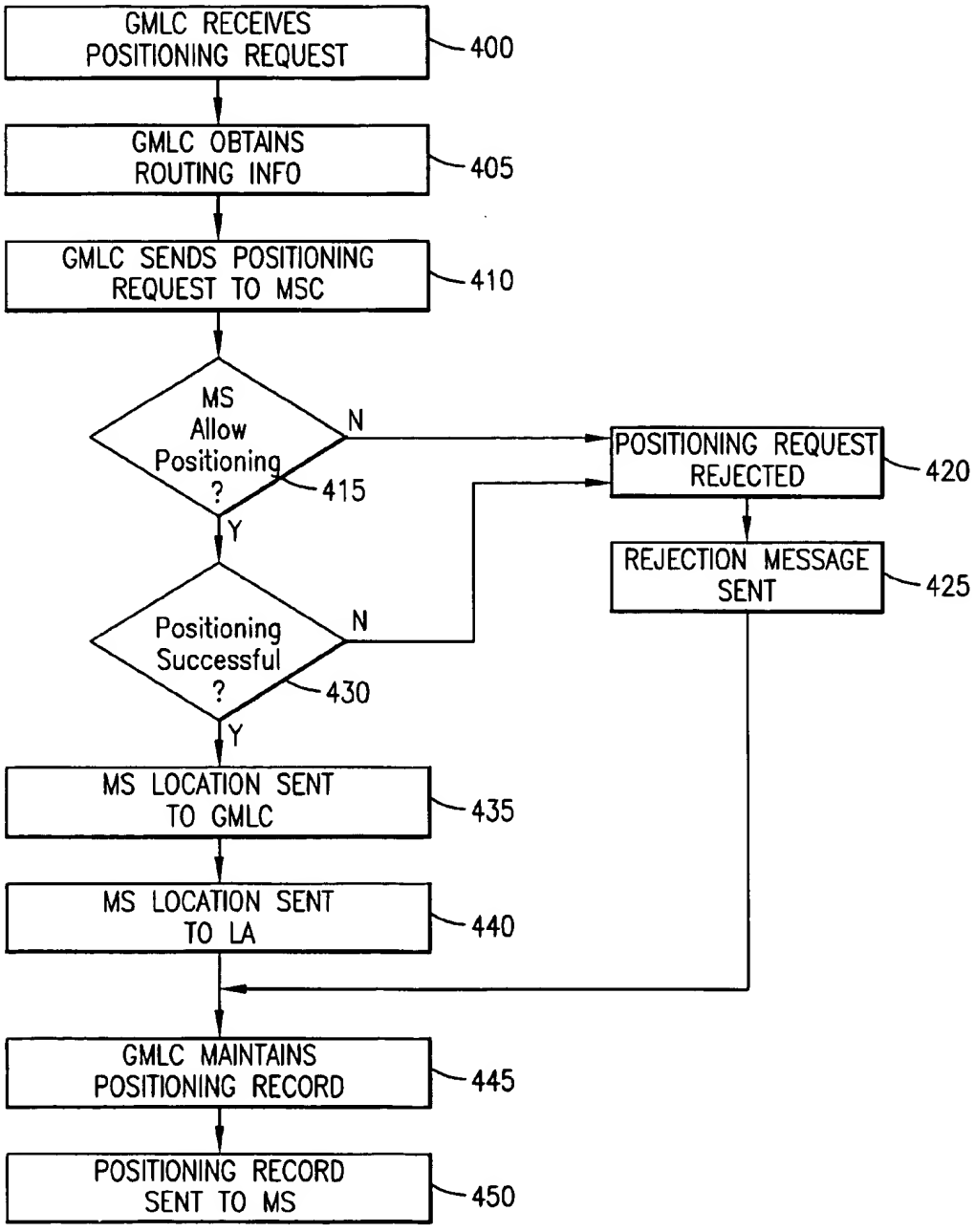

GMLC RECEIVES POSITIONING REQUEST
400
GMLC OBTAINS ROUTING INFO
405
GMLC SENDS POSITIONING REQUEST TO MSC
410
MS Allow Positioning ?
415
N
Y
POSITIONING REQUEST REJECTED
420
REJECTION MESSAGE SENT
425
Positioning Successful ?
430
N
Y
MS LOCATION SENT TO GMLC
435
MS LOCATION SENT TO LA
440
GMLC MAINTAINS POSITIONING RECORD
445
POSITIONING RECORD SENT TO MS
450

FIG. 4

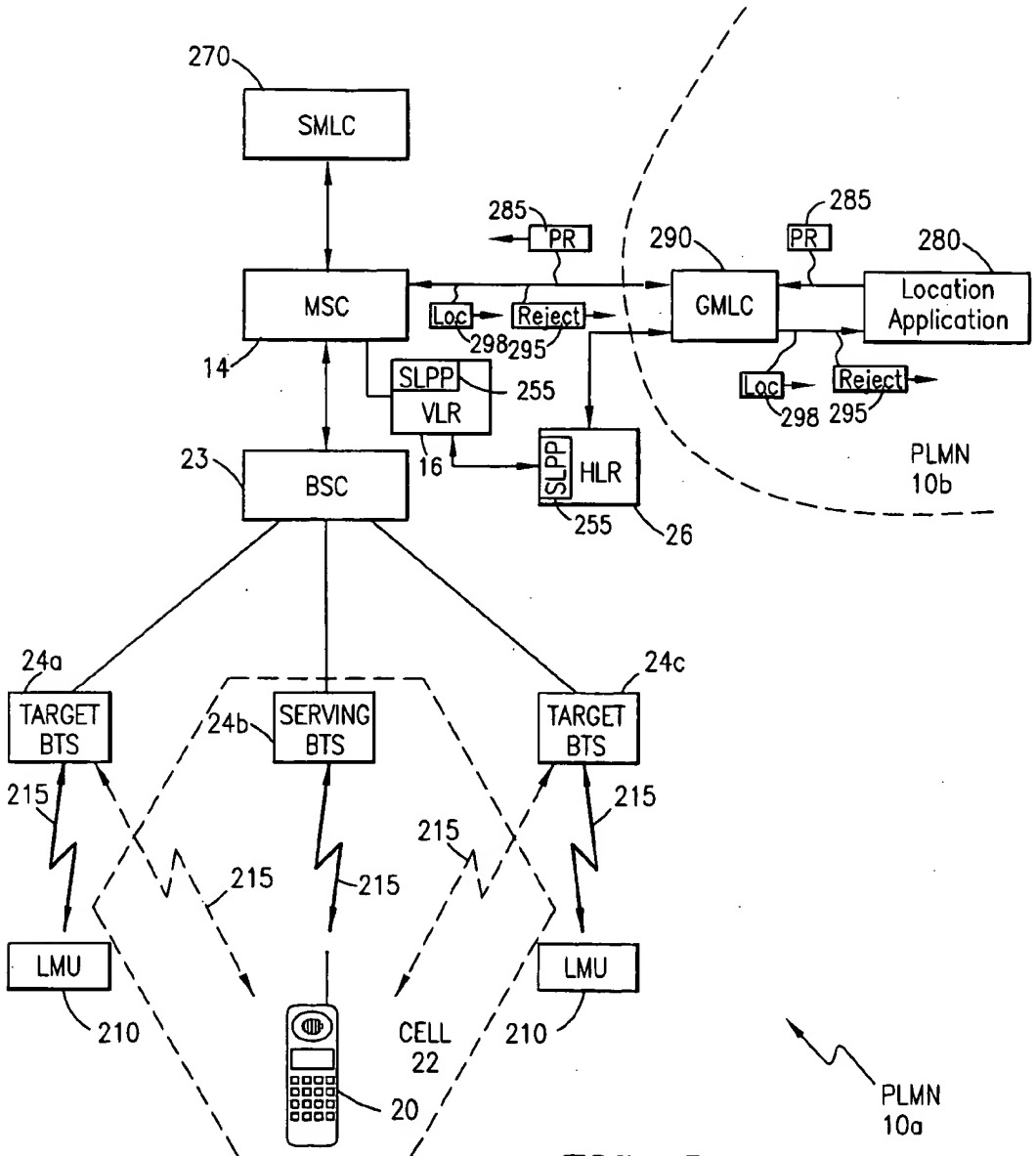

270
SMLC
285
PR
290
285
PR
280
MSC
Loc
Reject
GMLC
Location Application
298
295
14
SLPP
255
VLR
Loc
Reject
298
295
23
BSC
16
SLPP
HLR
255
26
PLMN 10b
24a
TARGET BTS
24b
SERVING BTS
24c
TARGET BTS
215
215
215
215
215
LMU
LMU
210
210
CELL 22
20
PLMN 10a

FIG. 5

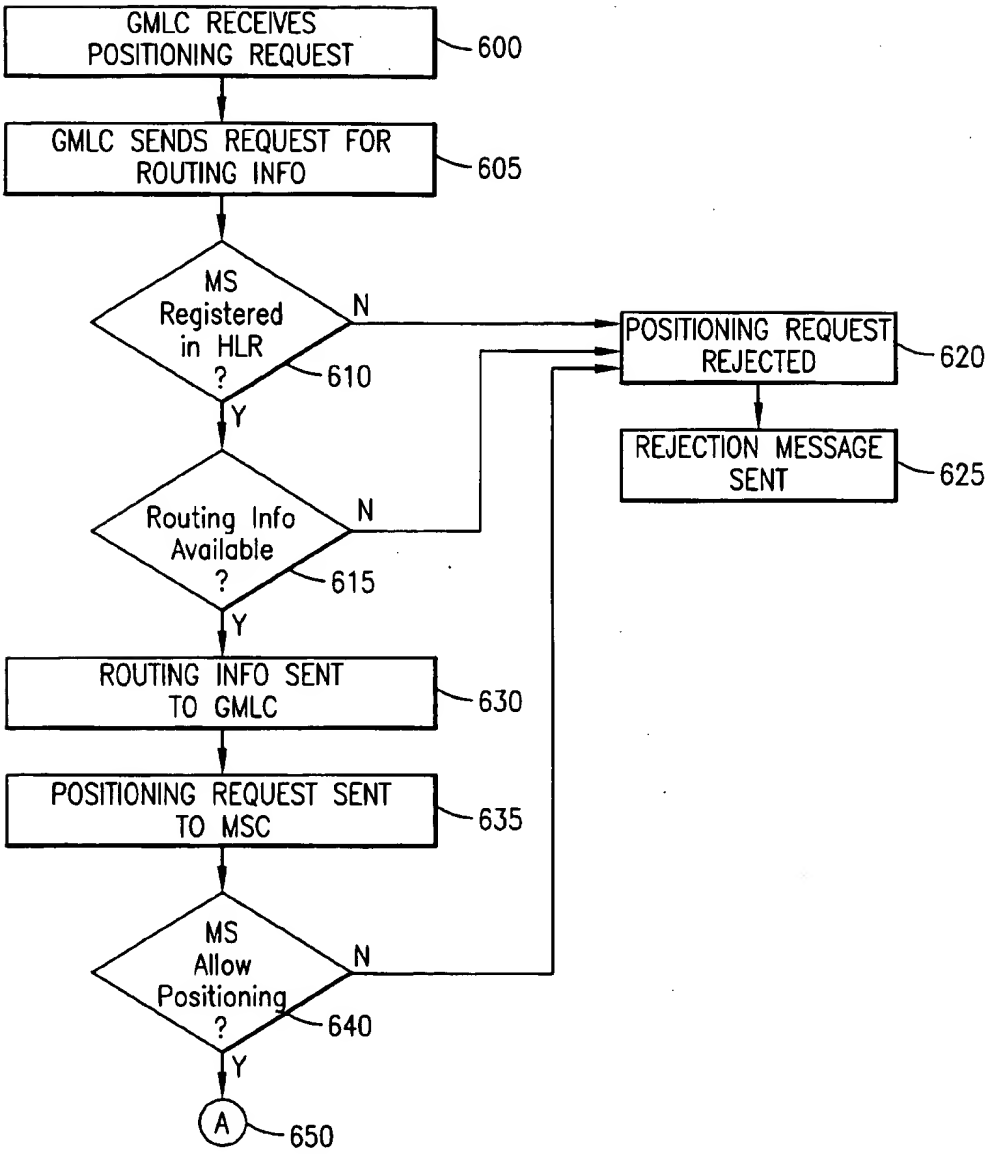

GMLC RECEIVES POSITIONING REQUEST
600
GMLC SENDS REQUEST FOR ROUTING INFO
605
MS Registered in HLR ?
610
N
Y
POSITIONING REQUEST REJECTED
620
REJECTION MESSAGE SENT
625
Routing Info Available ?
615
N
Y
ROUTING INFO SENT TO GMLC
630
POSITIONING REQUEST SENT TO MSC
635
MS Allow Positioning ?
640
N
Y
A
650

FIG. 6A

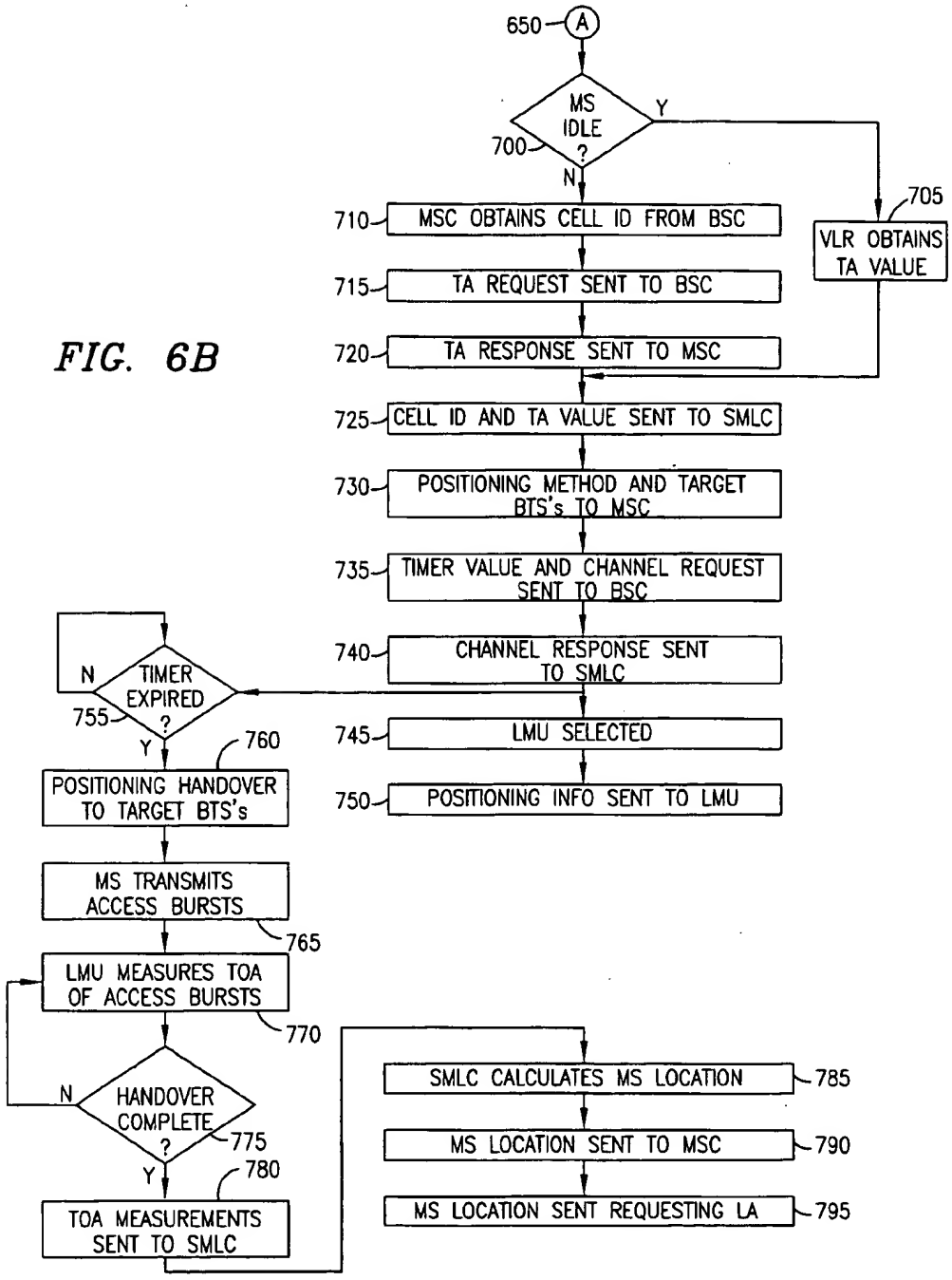

650
A
MS IDLE ?
700
Y
N
705
VLR OBTAINS TA VALUE
710
MSC OBTAINS CELL ID FROM BSC
715
TA REQUEST SENT TO BSC
720
TA RESPONSE SENT TO MSC
725
CELL ID AND TA VALUE SENT TO SMLC
730
POSITIONING METHOD AND TARGET BTS's TO MSC
735
TIMER VALUE AND CHANNEL REQUEST SENT TO BSC
740
CHANNEL RESPONSE SENT TO SMLC
745
LMU SELECTED
750
POSITIONING INFO SENT TO LMU
N
TIMER EXPIRED ?
755
Y
760
POSITIONING HANDOVER TO TARGET BTS's
MS TRANSMITS ACCESS BURSTS
765
LMU MEASURES TOA OF ACCESS BURSTS
770
N
HANDOVER COMPLETE ?
775
Y
780
TOA MEASUREMENTS SENT TO SMLC
SMLC CALCULATES MS LOCATION
785
MS LOCATION SENT TO MSC
790
MS LOCATION SENT REQUESTING LA
795

FIG. 6B

SYSTEM AND METHOD FOR MONITORING POSITIONING REQUESTS FOR MOBILE SUBSCRIBERS

BACKGROUND OF THE PRESENT INVENTION

1. Field of the Invention

The present invention relates generally to telecommunications systems and methods for positioning a mobile subscriber within a cellular network, and specifically to monitoring received positioning requests for a mobile subscriber.

2. Background and Objects of the Present Invention

Cellular telecommunications is one of the fastest growing and most demanding telecommunications applications. Today it represents a large and continuously increasing percentage of all new telephone subscriptions around the world. A standardization group, European Telecommunications Standards Institute (ETSI), was established in 1982 to formulate the specifications for the Global System for Mobile Communication (GSM) digital mobile cellular radio system.

With reference now to FIG. **1** of the drawings, there is illustrated a GSM Public Land Mobile Network (PLMN), such as cellular network **10**, which in turn is composed of a plurality of areas **12**, each with a Mobile Switching Center (MSC) **14** and an integrated Visitor Location Register (VLR) **16** therein. The MSC **14** provides a circuit switched connection of speech and signaling information between a Mobile Station (MS) **20** and the PLMN **10**. The MSC/VLR areas **12**, in turn, include a plurality of Location Areas (LA) **18**, which are defined as that part of a given MSC/VLR area **12** in which the MS **20** may move freely without having to send update location information to the MSC **14** that controls the LA **18**. Each LA **18** is divided into a number of cells **22**. The MS **20** is the physical equipment, e.g., a car phone or other portable phone, used by mobile subscribers to communicate with the cellular network **10**, each other, and users outside the subscribed network, both wireline and wireless.

The MSC **14** is in communication with at least one Base Station Controller (BSC) **23**, which, in turn, is in contact with at least one Base Transceiver Station (BTS) **24**. The BTS is the physical equipment, illustrated for simplicity as a radio tower, that provides radio coverage to the cell **22** for which it is responsible. It should be understood that the BSC **23** may be connected to several BTS's **24**, and may be implemented as a stand-alone node or integrated with the MSC **14**. In either event, the BSC **23** and BTS **24** components, as a whole, are generally referred to as a Base Station System (BSS) **25**.

With further reference to FIG. **1**, the PLMN Service Area or cellular network **10** includes a Home Location Register (HLR) **26**, which is a database maintaining all subscriber information, e.g., user profiles, current location information, International Mobile Subscriber Identity (IMSI) numbers, and other administrative information, for subscribers registered within that PLMN **10**. The HLR **26** may be co-located with a given MSC **14**, integrated with the MSC **14**, or alternatively can service multiple MSCs **14**, the latter of which is illustrated in FIG. **1**.

Determining the geographical position of an MS **20** within a cellular network **10** has recently become important for a wide range of applications. For example, location services (LCS) may be used by transport and taxi companies to determine the location of their vehicles. In addition, for

emergency calls, e.g., 911 calls, the exact location of the MS **20** may be extremely important to the outcome of the emergency situation. Furthermore, LCS can be used to determine the location of a stolen car, for the detection of home zone calls, which are charged at a lower rate, for the detection of hot spots for micro cells, or for the subscriber to determine, for example, the nearest gas station, restaurant, or hospital, e.g., "Where am I" service.

As can be seen in FIG. **2** of the drawings, upon a network positioning request, the MSC **14** obtains, from the serving BTS **24** and BSC **23**, a Timing Advance (TA) value, which corresponds to the amount of time in advance that the MS **20** must send a message in order for the serving BTS **24** to receive it in the time slot allocated to that MS **20**. The TA value, in turn, provides location information regarding the MS **20** location. This is due to the fact that when a message is sent from the MS **20** to the BTS **24**, there is a propagation delay, which depends upon the distance between the MS **20** and the BTS **24**. The TA values are expressed in bit periods, and can range from 0 to 63, with each bit period corresponding to approximately 550 meters between the MS **20** and the BTS **24**.

This TA value is forwarded to a Serving Mobile Location Center (SMLC) **270** for use in assisting the calculation of the geographical location of the MS **20**. It should be noted that the SMLC **270** can use a number of different positioning mechanisms, including, but not limited to, Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD) and Global Positioning System (GPS). After the SMLC **270** calculates the MS **20** location, this location can be sent to a Location Application (LA) **280** that requested the positioning. It should be noted that the requesting LA **280** could be located within the MS **20** itself, within the MSC **14** or could be an external node, such as an Intelligent Network (IN) node. If the LA **280** is not within the MS **20** or within the MSC **14**, the location information is sent to the requesting LA **280** via the MSC **14** and a Gateway Mobile Location Center (GMLC) **290**.

Existing technology can provide mobile subscribers with the ability to prevent LAs **280** from positioning them in order to protect their privacy. However, in some cases, it is necessary for the specific LA **280** to position the MS **20** regardless of the privacy settings of the particular subscriber. For example, when the LA **280** is an emergency center or a law enforcement agency, the community interest in positioning the MS **20** outweighs the subscriber's need for privacy. In this case, the privacy settings of the subscriber will need to be overridden in order for the emergency center or law enforcement agency to position the MS **20**. in addition, LAs **280** may need to have the ability to override other location settings established by the subscriber. Thus, a Privacy Override Indicator (POI) (not shown) can be provided by network operators to allow an LA **280** to override the subscriber's privacy settings in order to obtain the location of the mobile subscriber.

The POI is typically assigned on an individual LA **280** basis by a Gateway Mobile Location Center (GMLC) (not shown) during the registration of the LA **280** at the GMLC associated with the PLMN **10** that the LA **280** is located in. Normally, commercial-type LA's **280** are not allowed to override the subscriber's privacy settings, e.g., the assigned value of the POI is "not override." However, certain specific LA's **280**, such as law enforcement or E-**911**, which must be capable of positioning a subscriber regardless of the subscriber's privacy settings, can be assigned a POI with the value "allowed to override subscriber's privacy settings." It should be noted that when the subscriber is roaming, law

enforcement LA's **280** will need, in addition to the POI with the value "allowed to override subscriber's privacy settings," a court order in order to be able to override the mobile subscriber's privacy settings.

Furthermore, even though a mobile subscriber has established privacy settings, the mobile subscriber may want to allow certain other subscribers or LAs **280** to have the ability to position the mobile subscriber regardless of the mobile subscriber's privacy settings. Such other subscribers could be, for example, the mobile subscriber's family or member (s) of a particular group, such as, e.g., in the case where the subscriber is an employee of a taxi company, the operations center or the mobile subscriber's manager. For those cases, the mobile subscriber may also want to put limits on the ability of those other subscribers or LA's **280** to position him or her. For example, the mobile subscriber may only want to allow certain LA's **280** to be able to position the mobile subscriber during certain hours or minutes of the day, certain days of the week or certain days, weeks or months of the year. In addition, the mobile subscriber may want to limit the number of allowable repetitive positionings by a particular subscriber or LA **280** per hour, day, week or year.

Therefore, each mobile subscriber can define a Subscriber Location Privacy Profile (SLPP) (not shown), which contains a list of preferred subscribers or LA's **280** that have permission to position the mobile subscriber. The SLPP can also define the conditions under which each of the preferred LA's **280** can position the mobile subscriber. For example, the mobile subscriber can limit the positioning by a particular preferred LA **280** to only certain hours of the day, certain days of the week and/or certain weeks of the year, and can limit the number of times that particular preferred LA **280** can request positioning of the mobile subscriber during those allowed times. The SLPP can preferably be connected to the mobile subscriber's main subscription record in the HLR **26** and can be downloaded to the VLR **16** together the rest of the subscription information when the MS **20** is within the MSC/VLR area **12** (shown in FIG. **1**).

By allowing a mobile subscriber to preserve his or her privacy, an LA **280** may fail in it's attempt to position the mobile subscriber due to a restriction within the mobile subscribers SLPP. However, there is currently no mechanism for providing the identities of these failed requesting LA's **280** to a mobile subscriber. This type of identity information may be beneficial to a mobile subscriber who has been threatened or who has requested certain individuals to not position him or her. Furthermore, LA **280** identity information might be useful to law enforcement agencies conducting an investigation of a missing person, stolen vehicle or stolen property or other type of crime against the mobile subscriber. For example, if a mobile subscriber was positioned by an LA **280**, and that mobile subscriber is reported as missing, a law enforcement agency can determine the identity of the requesting LA **280**, and subpoena that LA's **280** records to determine the last known location of the missing mobile subscriber. Furthermore, in some cases, the LA **280** identity information may be useful to law enforcement agencies in tracking down criminals who try to position their victims.

Even if an LA **280** is successful in positioning an MS **20**, the mobile subscriber is not provided with LA **280** identity information during or after the positioning. Many mobile subscriber's may be curious about who is positioning them. In sum, regardless of whether a positioning request is successful or unsuccessful, the mobile subscriber does not have any knowledge of the identity of the requesting LA **280**.

It is, therefore, an object of the present invention to monitor all successful and unsuccessful attempts by a third party to locate a mobile subscriber and to provide identity information concerning that third party to the mobile subscriber.

It is a further object of the present invention to send Location Application identity information directly to a mobile station that was positioned successfully or unsuccessfully.

It is still a further object of the present invention to include Location Application identity information concerning Location Applicant's that attempt to position a mobile subscriber on that mobile subscriber's monthly bill.

It is still a further object of the present invention to maintain a positioning subscriber record including a list of the identities of all requesting Location Applications for a mobile subscriber.

SUMMARY OF THE INVENTION

The present invention is directed to telecommunications systems and methods for monitoring all successful and unsuccessful attempts by third parties to locate a mobile subscriber and providing identity information associated with those third parties to the mobile subscriber. Whenever a positioning request is received by a Gateway Mobile Location Center (GMLC), the GMLC, before returning a response to the requester, e.g., either location information or a rejection message, maintains a record of all information related to the positioning request, including the identity of the requester. The GMLC can download this positioning record to the mobile subscriber's Home Location Register (HLR), which can append at least identity information regarding the requester, and preferably, a time stamp, to the mobile subscriber's permanent record in the HLR. The identity information can be provided directly to the mobile subscriber on the Mobile Station (MS) associated with the mobile subscriber and/or included in the mobile subscriber's monthly bill.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed invention will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification hereof by reference, wherein:

FIG. **1** is a block diagram of a conventional wireless telecommunications system;

FIG. **2** is a block diagram illustrating some aspects involved in a conventional positioning of a mobile station within a cellular network;

FIG. **3** illustrates the collection, storage and transmission of information related to positioning requests received by a Gateway Mobile Location Center for a mobile station in accordance with embodiments of the present invention;

FIG. **4** shows steps in a sample implementation of the collection, storage and transmission process shown in FIG. **3** of the drawings in accordance with embodiments of the present invention;

FIG. **5** illustrates a sample positioning of a mobile station within a cellular network; and

FIGS. **6**A and **6**B show steps in implementing the sample positioning shown in FIG. **5** of the drawings.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

The numerous innovative teachings of the present application will be described with particular reference to the

presently preferred exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others.

With reference now to FIG. **3** of the drawings, which will be described in connection with FIG. **4** of the drawings, positioning of a particular target MS **20** typically begins by a Location Application (LA) **280** sending a positioning request **285**, which specifies the particular Mobile Station Integrated Services Digital Network (MSISDN) number associated with the target MS **20** to be positioned, to receiving logic within a Gateway Mobile Location Center (GMLC) **290** within the Public Land Mobile Network (PLMN) **10** of the LA **280** (step **400**). In response to receiving the positioning request **285** (step **400**), the GMLC **290** obtains routing information, e.g., the address for a serving Mobile Switching Center (MSC) **14** from a Home Location Register (HLR) associated with the MS **20** (step **405**). Using this MSC **14** address, the GMLC **290** routes the positioning request **285** to the serving MSC.

Once the MSC **14** receives the positioning request (step **410**), determination logic **250** within the MSC **14** determines if the requesting LA **280** is allowed to position the MS **20** (step **415**). For example, the MSC **14** can first determine whether the MS **20** subscriber has subscribed to positioning services, e.g., Location Services (LCS). If the MS **20** subscriber does subscribe to LCS, the MSC **14** can also compare LA identity information contained within the MS **20** subscriber's Subscriber Location Privacy Profile (SLPP) **255**, which is stored within a Visitor Location Register (VLR) **16** associated with the MSC **14**, with the LA identity of the requesting LA **280**, which is provided with the received positioning request **285**, to verify that the MS **20** subscriber does allow positioning to be performed by that requesting LA **280**. It should be understood that the LCS and SLPP **255** information is downloaded to the serving VLR **16** associated with the serving MSC **14** together the rest of the mobile subscriber's subscription information with the existing Mobile Application Part (MAP) operation INSERT_SUBSCRIBER_DATA or with the existing MAP operation RESTORE_DATA when the MS **20** registers with the serving MSC **14**. In addition, it should be understood that, in some networks, if the MS **20** has not subscribed to any LCS and/or has not defined an SLPP **255**, the requesting LA **280** cannot position the MS **20**, unless the requesting LA **280** is, for example, a law enforcement agency or an emergency services application.

If the requesting LA **280** is not allowed to position the MS **20** (step **415**), the MSC **14** rejects the positioning request **285** (step **420**) and a rejection message **295** is sent to the requesting LA (step **425**). However, if the requesting LA **280** is allowed to position the MS **20** (step **415**), the MSC **14** carries out the positioning request (step **430**).

If the serving MSC **14** is unable to successfully position the MS **20** (step **430**), the MSC **14** rejects the positioning request **285** (step **420**), and sends a rejection message **295** to the requesting LA **280** via the GMLC **290** (step **425**). However, if the serving MSC **14** is able to successfully position the MS **20** (step **430**), the location **298** of the MS **20** is sent to the GMLC **290** (step **435**), which can forward this location information to the requesting LA **280** (step **440**).

After the positioning process is completed (step **420** or **440**), whether successful (step **440**) or unsuccessful (step **420**), the GMLC **290** maintains a positioning record **265** per mobile subscriber **268** of all of the relevant positioning information **271** regarding each positioning request **285** received for each mobile subscriber **268** (step **445**). Each positioning record **265** can be, for example, a part of a database **262** stored within a memory **260** of the GMLC **290**. It should be noted that if the mobile subscriber does not subscribe to LCS, or if the mobile subscriber is roaming in a visiting Public Land Mobile Network (PLMN) **10**, the GMLC **290** maintains a temporary positioning record **265** per visiting or non-LCS mobile subscriber **268**.

The positioning information **271** recorded per mobile subscriber **268** includes identity information **272** concerning the identity of the LA **280** that sent the positioning request **285** for the mobile subscriber. In addition, date and time information **274** associated with the date and time of each received positioning request **285**, as well as location information **276** associated with the mobile subscriber's location at the time of the positioning (if successful), can be stored in the mobile subscriber's positioning record **265**. Furthermore, a successful indicator **277** indicating whether the positioning request was successful or unsuccessful, as well as the reason if unsuccessful, along with an override indicator **278** indicating whether the mobile subscriber's privacy was "overridden" can also be stored in the mobile subscriber's positioning record **265**. However, it should be understood that in some cases this "override" information may not be revealed to the mobile subscriber. For example, if the requesting LA **280** is a law enforcement agency, this "override" information will not be provided to the mobile subscriber.

After the GMLC **290** collects and stores all of the relevant positioning information **271** for the positioning request **285** in the mobile subscriber's positioning record **265** (step **445**), transmitting logic **258** within the GMLC **290** can send this record **265** to the MS **20** associated with the mobile subscriber (step **450**) in, for example, a Short Message Service (SMS) or Unstructed Supplementary Service Data (USSD) message **220** via the serving MSC **14**. The GMLC **290** can either send this SMS or USSD message **220** immediately after completion of the positioning process, whether successful or unsuccessful, or at a predefined frequency, e.g., once per day if any request **285** for positioning was received for the mobile subscriber. Alternatively, the GMLC **290** can forward the mobile subscriber's positioning record **265** to a billing center **230** associated with the MS's **20** home PLMN **10** to be included within the mobile subscriber's monthly bill **235**. It should be noted that if the mobile subscriber is visiting the network **10**, the temporary positioning record **265** associated with the mobile subscriber can also either be sent to the mobile subscriber as an SMS message **220** or be sent to the mobile subscriber's home PLMN **10** billing center **230** for inclusion in the mobile subscriber's monthly bill **235**.

In an alternative embodiment, downloading logic **240** within the GMLC **290** can download the mobile subscriber's positioning record **265** to the HLR **26** associated with the MS **20** immediately upon completion of the positioning process or at predefined intervals. The HLR **26** can append this positioning record **265**, and preferably, a time stamp **248**, to the mobile subscriber's permanent record **245** in the HLR **26**. The HLR **26** can, in turn, either send an SMS message **220** to the MS **20** via the MSC **14** or provide this record to the PLMN **10** billing center **230** for inclusion in the mobile subscriber's monthly bill **235**.

Alternatively, the GMLC **290** can still provide the mobile subscriber's positioning record **265** either directly to the MS

20, using an SMS or USSD message 220, or to the PLMN 10 billing center 230. Subsequently, after the GMLC 290 provides this positioning information 271 within the record 265 to the mobile subscriber, the downloading logic 240 within the GMLC 290 can download the mobile subscriber's positioning record 265 to the HLR 26 for permanent storage therein, and the GMLC 290 can delete from it's records any unnecessary or extraneous information not needed to be retained by the GMLC 290 for billing purposes of the requesting LA 280.

A more complete understanding of aspects of the positioning process involved in the present invention will now be described with reference to FIG. 5 of the drawings, which will be described in connection with FIGS. 6A and 6B of the drawings. When the GMLC 290 within the PLMN 10*b* of the requesting LA 280 receives the positioning request 285 (step 600), the GMLC 290 sends a request for routing information (step 605), e.g., the address of the serving MSC 14 within the PLMN 10*a* that the MS 20 is currently located in, to the MS's HLR 26, using the MS's 20 directory number as a global title. The signaling network, e.g., the Signaling System #7 (SS7) network (not shown), can perform a global title translation on the MSISDN and route the request to the appropriate HLR 26 for the MS 20.

The HLR 26 checks its records to confirm that the MS 20 is registered in the HLR 26 (step 610), and that routing information for that MS 20 is available (step 615). If the MS 20 is not registered in the HLR 26 (step 610) or the routing information is not available (step 615), the positioning request 285 is rejected (step 620) and the GMLC 290 sends a rejection message 295 to the requesting LA 280 (step 625). However, if the MS 20 is registered in the HLR 26 (step 610) and routing information for the MSC 14 is available (step 615), the routing information, e.g., the MSC 14 address is sent to the GMLC 290 (step 630). Using this MSC 14 address, the GMLC 290 transmits a MAP_PROVIDE_SUBSCRIBER_LOCATION message, which contains the positioning request 285, to the serving MSC 14 (step 635).

The MSC 14 verifies that the MS 20 allows positioning to be performed (step 640), e.g., by checking the SLPP 255, sent by the HLR 26 to the VLR 16, and if the MS 20 does not allow positioning (step 640), the positioning request 285 is rejected (step 620) and a rejection message 295 is sent to the LA 280 (step 625). If the mobile subscriber allows positioning (step 640), positioning of the MS 20 continues (step 650).

With reference now to the steps described in FIG. 6B of the drawings, if the MS 20 is in idle mode (step 700), the VLR 16 performs paging and authentication of the MS 20, along with ciphering of the positioning data. This procedure provides the current cell 22 ID and Timing Advance (TA) value for a serving Base Transceiver Station (BTS) 24*b* in a BSSMAP Complete layer 3 message, which is used to convey a paging response (step 705). However, if the MS 20 is in dedicated mode (step 700), e.g., involved in a call connection, the MSC 14 obtains the current cell 22 ID from a serving Base Station Controller (BSC) 23 (step 710) and sends a BSSMAP TA request to the serving BSC 23 (step 715). The serving BSC 23 obtains a current TA value from the serving BTS 24*b* and returns this current TA value in a BSSMAP TA response to the MSC 14 (step 720).

Upon receipt of the current cell 22 ID and TA value (step 705 or 720), the MSC 14 sends a MAP_PERFORM_LOCATION message, which includes the current cell 22 ID and TA value, to the SMLC 270 associated with the MS's 20 current cell 22 location (step 725). The SMLC 270 determines the positioning method to use, e.g., Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD) or Global Positioning System (GPS). If, for example, TOA is selected, the SMLC 270 sends a MAP Channel Information message, which contains an indication that TOA should be used along with a list of target BTS's 24*a* and 24*c* to which a positioning handover must be performed, to the MSC 14 (step 730). In response, the MSC 14 sends a BSSMAP CHANNEL INFORMATION message to the BSC 23, requesting a physical channel description of the allocated traffic channel, if the MS 20 is in dedicated mode. The BSSMAP CHANNEL INFORMATION message also includes a timer value (not shown) and the list of target BTS's 24*a* and 24*c* (step 735). The BSC 23 returns the physical channel description and other related information to the SMLC 270 via the MSC 14 (step 740).

Based upon this received information (step 740), the SMLC 270 selects at least one Location Measurement Unit (LMU) 210 to measure and transmit positioning data to the SMLC 270 (step 745). Positioning data measurement information, which includes the identity of at least one target BTS 24*a* to which a positioning handover must be performed, is sent to the selected LMU 210 via the MSC 14 over the air interface 215 (step 750).

At the expiration of the timer value in the BSC 23 (step 755), the BSC 23 informs the target BTS's 24*a* and 24*c* that a positioning handover needs to be performed (step 760). Taking one target BTS 24*a*, the BSC 23 sends a command to the MS 20 via the serving BTS 24*b* over the air interface 215 to transmit a HANDOVER ACCESS message, including access bursts, to the target BTS 24*a* (step 765). During the time that the MS 20 is waiting for a response from the target BTS 24*a*, e.g., around 320 milliseconds for a traffic channel, the LMU 210 measures the TOA of the access bursts sent by the MS 20 (step 770). After the target BTS 24a indicates to the BSC 23 in a HANDOVER DETECTION message that the required number of access bursts was received, and the MS 20 sends a HANDOVER COMPLETE message to the BSC 23 (step 775), the LMU 210 sends the TOA measurements to the SMLC 270 via the MSC 14 (step 780). Using these TOA measurements and the previously obtained TA value, the SMLC 270 calculates the location of the MS 20 (step 785) and transmits this location information 298 to the MSC 14 (step 790), which can forward this location information 298 to the requesting LA 280 via the GMLC 290 (step 795).

As will be recognized by those skilled in the art, the innovative concepts described in the present application can be modified and varied over a wide range of applications. Accordingly, the scope of patented subject matter should not be limited to any of the specific exemplary teachings discussed, but is instead defined by the following claims.

What is claimed is:

1. A gateway mobile location center for collecting, storing and transmitting positioning information related to a received positioning request for a mobile subscriber, comprising:

receiving logic for receiving said positioning request from a location node, said positioning request having identity information associated with said location node;

a memory having a database therein for storing at least one positioning record, said at least one positioning record being associated with said mobile subscriber, said at least one positioning record comprising at least said identity information; and

transmitting logic for transmitting at least said identity information within said at least one positioning record

to a home location register associated with said mobile subscriber, said home location register transmitting at least said identity information to said mobile subscriber.

2. The gateway mobile location center of claim 1, wherein said transmitting logic transmits at least said identity information to a mobile station associated with said mobile subscriber in a Short Message Service message.

3. The gateway mobile location center of claim 1, wherein said transmitting logic transmits at least said identity information to a mobile station associated with said mobile subscriber in an Unstructured Supplementary Service Data message.

4. The gateway mobile location center of claim 1, wherein said transmitting logic transmits at least said identity information to a billing center of a home network associated with said mobile subscriber.

5. The gateway mobile location center of claim 1, wherein said at least one positioning record further comprises date and time information associated with the date and time said positioning request was received.

6. The gateway mobile location center of claim 1, wherein said at least one positioning record further comprises a successful indicator for indicating whether said positioning request was successful and location information if said successful indicator indicates that said positioning request was successful.

7. The gateway mobile location center of claim 1, wherein said at least one positioning record further comprises an override indicator for indicating whether privacy information associated with said mobile subscriber was overridden by said location node.

8. The gateway mobile location center of claim 7, wherein said privacy information is a Subscriber Location Privacy Profile.

9. A telecommunications system for maintaining positioning information associated with a positioning request for a mobile subscriber and transmitting at least portions of said positioning information to said mobile subscriber, comprising:

a gateway mobile location center for receiving a positioning request having identity information associated therewith for said mobile subscriber and transmitting at least said identity information to said mobile subscriber;

a positioning record associated with said mobile subscriber within a database within a memory of said gateway mobile location center for storing at least said identity information; and

a home location register associated with said mobile subscriber for receiving at least said identity information within said at least one positioning record from said gateway mobile location center and transmitting at least said identity information to said mobile subscriber.

10. The telecommunications system of claim 9, further comprising:

a mobile station associated with said mobile subscriber for receiving at least said identity information from said gateway mobile location center in a Short Message Service message.

11. The telecommunications system of claim 9, further comprising:

a billing center of a home network associated with said mobile subscriber for receiving at least said identity information from said gateway mobile location center and producing a bill for said mobile subscriber including at least said identity information.

12. The telecommunications system of claim 9, wherein said positioning record further comprises date and time information associated with the date and time said positioning request was received.

13. The telecommunications system of claim 9, wherein said positioning record further comprises a successful indicator for indicating whether said positioning request was successful and location information if said successful indicator indicates that said positioning request was successful.

14. The telecommunications system of claim 9, wherein said positioning record further comprises an override indicator for indicating whether said privacy information associated with said mobile subscriber was overridden by said location node.

15. The telecommunications system of claim 14, wherein said privacy information is a Subscriber Location Privacy Profile.

16. The telecommunications system of claim 9, wherein said home location register further comprises:

a subscriber record associated with said mobile subscriber, said positioning record being appended to said subscriber record along with a time stamp.

17. A method for maintaining positioning information associated with a positioning request for a mobile subscriber and transmitting at least portions of said positioning information to said mobile subscriber, comprising the steps of:

receiving, by a gateway mobile location center, a positioning request having identity information associated therewith for said mobile subscriber;

storing, within a positioning record associated with said mobile subscriber within said gateway mobile location center, at least said identity information; and

transmitting at least said identity information to a home location register associated with said mobile subscriber, said home location register transmitting at least said identity information to said mobile subscriber.

18. The method of claim 17, wherein said step of transmitting further comprises the step of:

transmitting at least said identity information to a mobile station associated with said mobile subscriber in a Short Message Service message.

19. The method of claim 17, wherein said step of transmitting further comprises the step of:

transmitting at least said identity information to a mobile station associated with said mobile subscriber in an Unstructured Supplementary Service Data message.

20. The method of claim 17, wherein said step of transmitting further comprises the steps of:

transmitting at least said identity information to a billing center of a home network associated with said mobile subscriber; and

producing, by said billing center, a bill for said mobile subscriber including at least said identity information.

21. The method of claim 17, wherein said step of storing further comprises the step of:

storing, within said positioning record, date and time information associated with the date and time said positioning request was received.

22. The method of claim 17, wherein said step of storing further comprises the step of:

storing, within said positioning record, a successful indicator for indicating whether said positioning request

was successful and location information if said successful indicator indicates that said positioning request was successful.

23. The method of claim 17, wherein said step of storing further comprising the step of:

storing, within said positioning record, an override indicator for indicating whether privacy information associated with said mobile subscriber was overridden by said location node.

24. The method of claim 17, wherein said step of receiving at least said identity information by said home location register further comprises the step of:

appending, to a subscriber record associated with said mobile subscriber within said home location register, at least said identity information and a time stamp.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,463,288 B1
DATED : October 8, 2002
INVENTOR(S) : Theodore Havinis et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [57], **ABSTRACT**,
Lines 7 and 11, replace "requester" with -- requestor --

Column 2,
Lines 49-50, replace "in addition" with -- In addition --

Column 4,
Lines 27, 30 and 33, replace "requester" with -- requestor --

Signed and Sealed this

Eleventh Day of February, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office